

**EXPLORING THE MOON IN THE 21<sup>ST</sup> CENTURY: THEMES, GOALS, OBJECTIVES, INVESTIGATIONS, AND PRIORITIES, 2008: THEME 1, Goals 1A and 1B: Fundamental Lunar Science Questions.** G. Jeffrey Taylor, Hawaii Inst. of Geophysics and Planetology, University of Hawaii, Honolulu, HI 96822 ([gjtaylor@higp.hawaii.edu](mailto:gjtaylor@higp.hawaii.edu)).

**Introduction:** The Lunar Exploration Advisory Group (LEAG) has been charged by NASA with compiling input from the lunar community worldwide on the science and engineering considerations that should be addressed in plans for the exploration of the Moon and establishment of a human presence at a permanent lunar outpost. These ideas, principles, and concepts will be rendered into a formal NASA report on recommendations for the future of lunar exploration.

The three major themes that entail this noble endeavor are Theme 1: Pursue scientific activities to address fundamental questions about the solar system, the universe, and our place in them; Theme 2: Use of the Moon to prepare for future missions to Mars and other destinations; and Theme 3: Extend sustained human presence to the Moon to enable eventual settlement. Specifically, this paper addresses *Theme 1, Goal 1A (Basic Lunar Science) and Goal 1B (Moon as a witness plate)*. The Objectives and Investigations within each of these goals, in tentative priority order, are summarized below. These form the basis for our open forum at the 1<sup>st</sup> Lunar Science Conference.

**Goal 1A: Understand the formation, evolution, and current state of the Moon.**

**Objective 1A-1: Understand the geological evolution of the Moon (and other terrestrial bodies)**

*Investigation 1: Determine the internal structure and dynamics of the Moon to constrain the origin, composition, and structure of the Moon (and other planetary bodies).*

*Investigation 2: Determine the composition and evolution of the lunar crust and mantle to constrain the origin and evolution of the Moon (and other planetary bodies).*

*Investigation 3: Characterize the crustal geology of the Moon via the regolith to identify the range of geological materials present.*

*Investigation 4: Characterize the lunar geophysical state variables to constrain the origin, composition, and structure of the Moon (and other planetary bodies).*

**Objective 1A-2: Study of endogenous and exogenous volatiles on the Moon.**

*Investigation 1: Characterize transport of lunar volatiles to understand the processes of polar volatile deposit origin and evolution.*

*Investigation 2: Characterize lunar volatile and siderophile elements and their sources to determine their origin and to reveal the nature of impactors on the Moon.*

*Investigation 3: Determine the origin and distribution of endogenous lunar volatiles as one input to understanding the origin, composition, and structure of the Moon*

**Objective 1A-3: Improve knowledge of impact processes and impact history of the Moon.**

*Investigation 1: Characterize impact flux over the Moon's geologic history.*

*Investigation 2: Characterize the impact process, especially for large basins, to understand this complex process.*

**Objective 1A-4: Characterization of regolith and mechanisms of regolith formation and evolution.**

*Investigation 1: Study the lunar regolith to understand the nature and history of solar emissions, galactic cosmic rays, and the local interstellar medium.*

*Investigation 2: Characterize volatiles and other materials to understand their potential for lunar resource utilization.*

*Investigation 3: Determine lunar regolith properties to understand the subsurface geology and environment of the Moon and other airless bodies.*

**Objective 1A-5: Development and implementation of sample return technologies and protocols.**

*Investigation 1: Provide curatorial facilities and technologies to ensure contamination and environmental control for lunar samples.*

*Investigation 2: Provide sample analysis instruments and protocols on the Moon to analyze lunar samples before returning them to Earth.*

**Objective 1A-6: Understand the environmental impacts of lunar exploration.**

*Investigation 1: Determine baseline lunar environment parameters (exosphere, dust, radiation, etc., including composition and fluctuations therein).*

*Investigation 2: Establish a pre-human return monitoring network to quantify the environmental perturbations associated with exploration as well as due to natural phenomena (e.g., solar flares, meteoroid impacts, etc.).*

**Goal 1B: Use the Moon as a “witness plate” for solar system evolution.**

**Objective 1B-1: Understand the space weathering process to evaluate its effects on the Moon and other airless bodies.**

*Investigation 1: Characterize the lunar regolith to understand the space weathering process in different crustal environments.*